EETF Quarterly Progress Report

Grant # 7310029

Safe and Efficient Exhaust Thimble

Submitted by:

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Institute of Northern Engineering (INE)

Period: January 1, 2014 – March 31, 2014 (Q1)

Summary

The project Budget/Milestone Schedule from the Grantee's original scope of work is shown below. No changes to this scope have been made or requested. A 6-month no-cost extension was granted, and the current project end date is June 30, 2014.

Milestone		Task	Start Date	End Date	Grant Funds	Match Funds	Total Budget	Deliverables
	1	Purchase and assembly of DAQ and instrumentation	Feb 2013	Feb 2013	$12,196		$12,196	DAQ system "dry-run" data set to ACEP for plan verification
	2	High fidelity performance test of 2-inch thimble	Mar 2013	Mar 2013	$11,193	$5793	$16,986	Performance test results
MS 1: AEA accepts performance test results								
	3	Design, construct and testing of 4, 6, 8, and 10-inch thimbles	Apr 2013	Oct 2013	$62,868		$62,868	Performance test results
	4	Draft project report	Nov 2013	Dec 2013	$816		$816	Draft project report
	5	Final project report	Dec 2013	Jan 2014	$816		$816	Final project report
MS 2: AEA accepts final report								
Total					$87889	$5793	$93,682	

Deliverables Submitted

Task 1 and task 2 are complete. Work continued this review period on task 3, which is now largely complete. The project is scheduled to be completed on June 30, 2014, and work is on schedule for completion at that time.

Budget

Total funds expended to date are $15,146 of the grant total $87,889.00 (~21%). However, several expenditures have not been recorded on the project yet due to the way personnel services and UAF contractual services are recorded. The primary expenditure during this quarter was personnel services (salary) during work on task 3.

Schedule Status

Tasks 1 and 2 are complete, and Task 3 is approximately 70% complete. All four thimbles in task 3 have been constructed and tested a minimum of 4 non-consecutive times. As the initial 6-inch thimble was a prototype, it is planned to build another 6-inch version consistent with the current design and construction of the other thimbles. A graduate research assistant began working on the project this quarter to assist the undergraduate assistant who no longer could devote the requisite time to the project testing. The graduate assistant will continue on the project through its completion on June 31, 2014.

Percent Complete

The estimated percent completion of the 5 project tasks is shown in the table below.

Task 1: 100%	Task 2: 100%	Task 3: 70%	Task 4: 0%	Task 5: 0%

Task 1, *Purchase and assembly of DAQ and instrumentation*, is complete. This task was under budget because several pieces of equipment were obtained through surplus from previous university projects. This includes the data collection computer, A/D hardware box from National Instruments, and several non-grounded thermocouples. The pitot tube acquired in Q4 2013 was still not able to record reliably at higher temperatures, and so a pinwheel anemometer was purchased in Q1 2014. This does appear to be recorded consistently and reasonably accurately.

Task 2, *High fidelity performance test of thimble*, is complete. Reproducible temperature data are being collected from 9 different locations on the thimble, and repeat measurements are made non-consecutively in order to avoid systematic errors. The new pinwheel anemometer is able to measure air flow through the cooling channel with reproducible results.

Task 3, *Design and Construction of Four New Thimbles*, is approximately 70% complete. All four of the thimbles have been constructed and tested at least four different times. Temperature data are recorded at the 9 key locations, and air flow is measured in at one location in the cooling channel.

Work Progress

There are four version of the thimble in different diameters: 2 inch, 4 inch, 6 inch, and 10 inch. Each thimble is tested at four different exhaust temperatures: 400°F, 600°F, 800°F and 1000°F. Temperature data are recorded using thermocouples installed at 9 key locations: exhaust inlet, exhaust outlet, vent inlet, vent outlet (4 radial locations), thimble base, and thimble/ceiling junction. Temperature data are recorded once per minute via computer control and a National Instruments SCXI DAQ system.

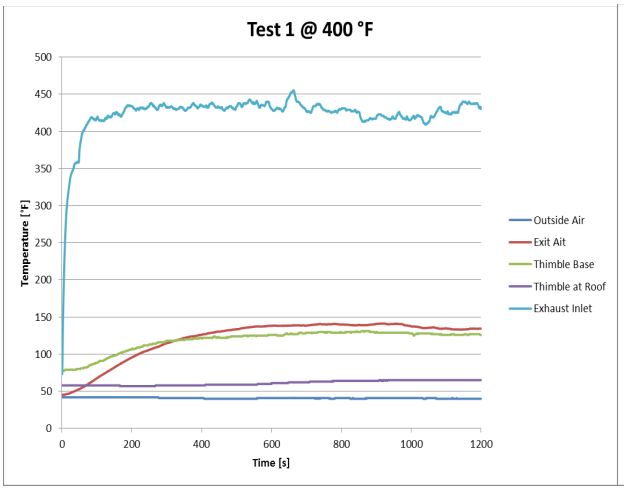
The air flow through the thimble vent channel is recorded manually. The protocol for this measurement is to wait until a pseudo-steady state has been reached in temperature (see figures below), and then the operator measured the flow rate into the thimble vent by hand on the roof. Recordings using the pinwheel anemometer are made at several radial locations, and an average value is recorded. This is repeated several times at 5-10 minute intervals to look for changes. There is about a 20% variation in recordings each time, which we determined was sufficient. The rationale for this is that air flow velocity is not the desired feature of the thimble, but an indicator that the thimble is operating as designed. The desired design goal is a reduced temperature at the thimble/ceiling interface.

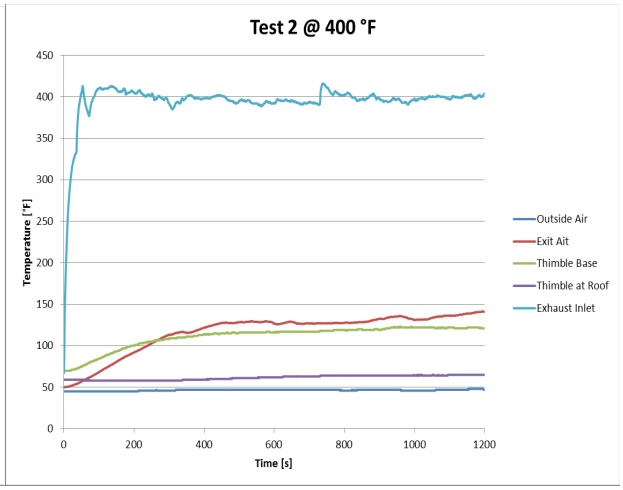
With the acquisition of the new flow velocity meter, the the numerical model can now be verified using both temperature and air velocity data. The current model agrees with the flow velocity within about a factor of 2 (100%). Temperature data agree within about 50%. During the remaining duration of the project,the numerical model will be refined in an attempt to attain closer agreement with the experimental data.

The following pages show representative data from the 4-inch thimble at 4 different temperatures. Comparison with earlier progress reports shows that the experimental protocol reproducibility has improved substantially.

Future Work

Complete Task 3 by project end date of June 30.


Test 1 @ 400 °F
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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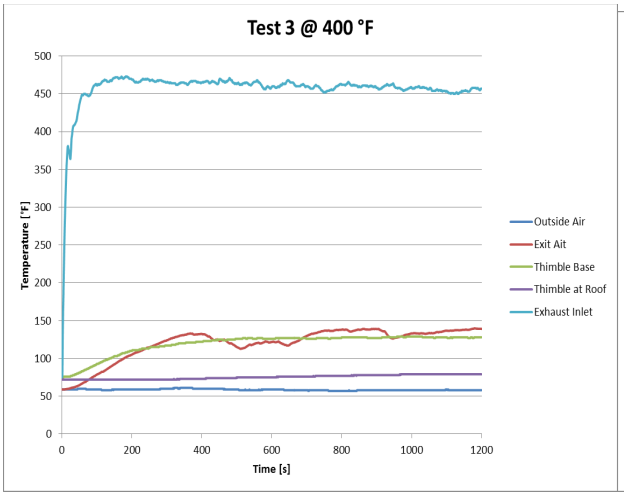
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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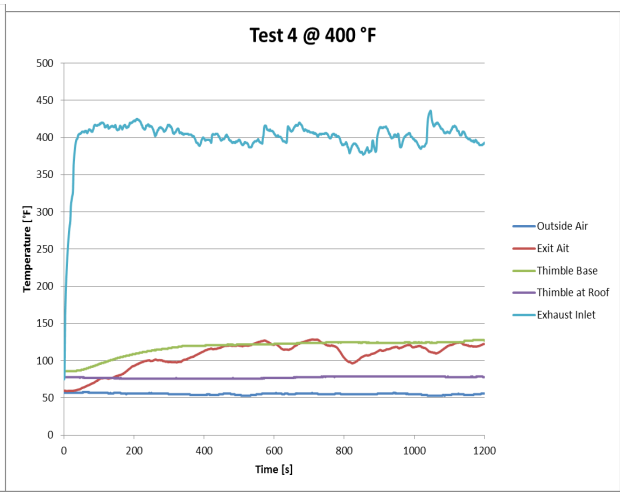
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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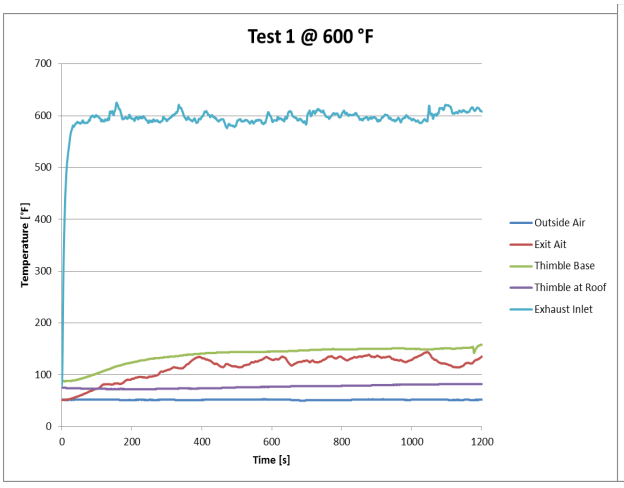
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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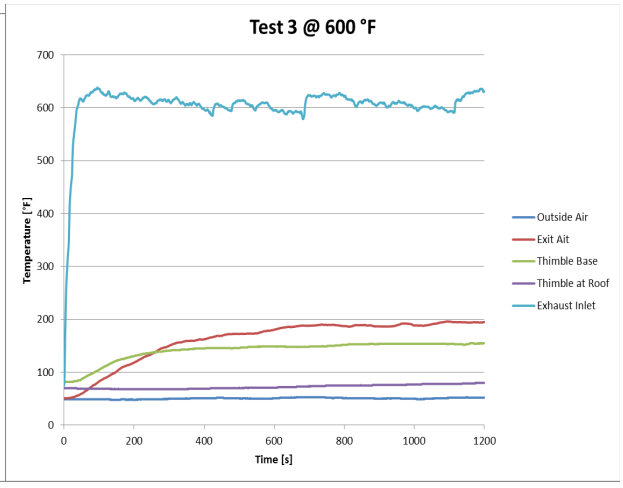
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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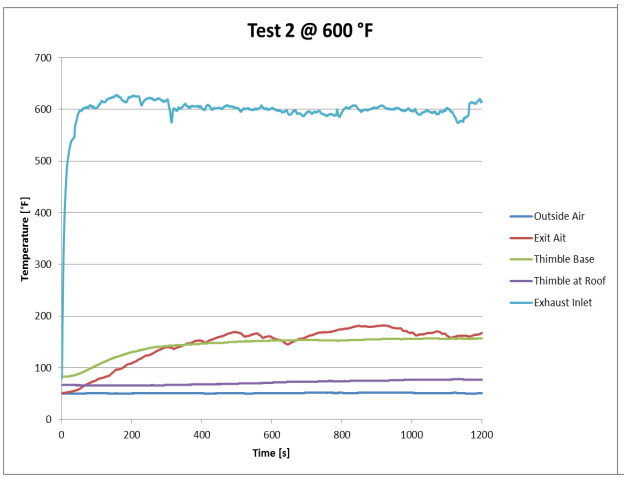
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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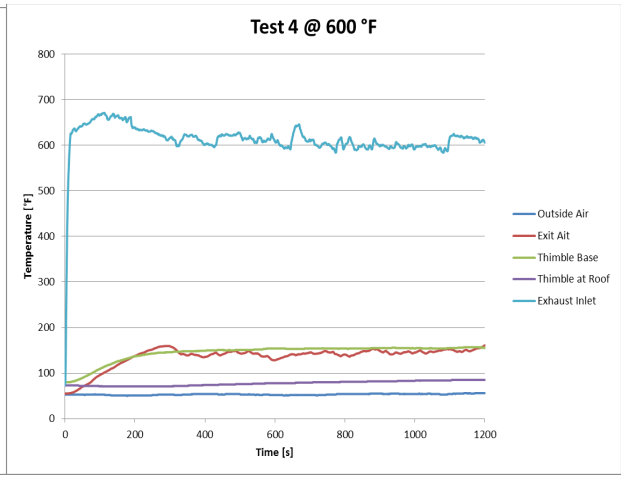
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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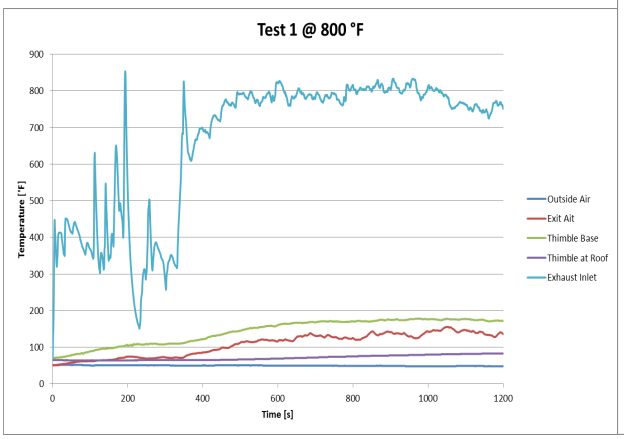
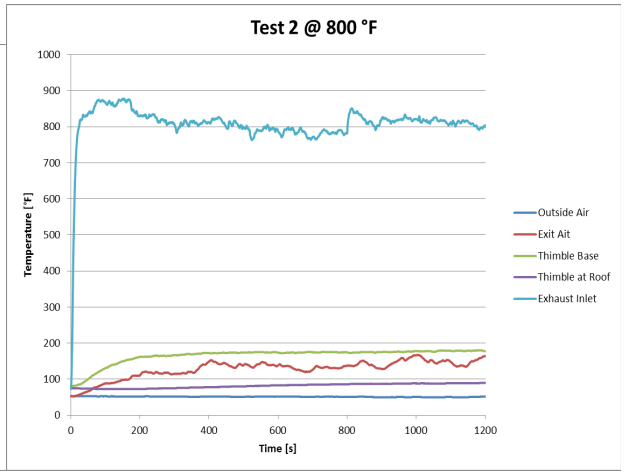
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet


Test 1 @ 800 °F
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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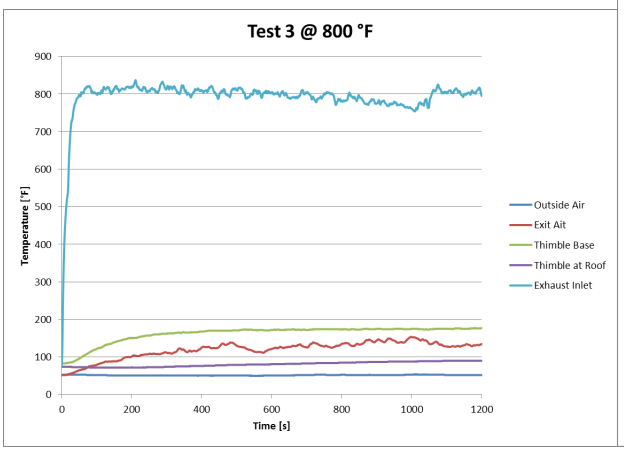
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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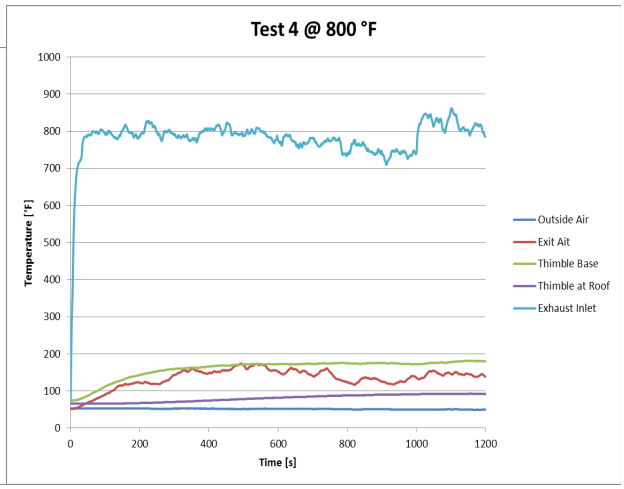
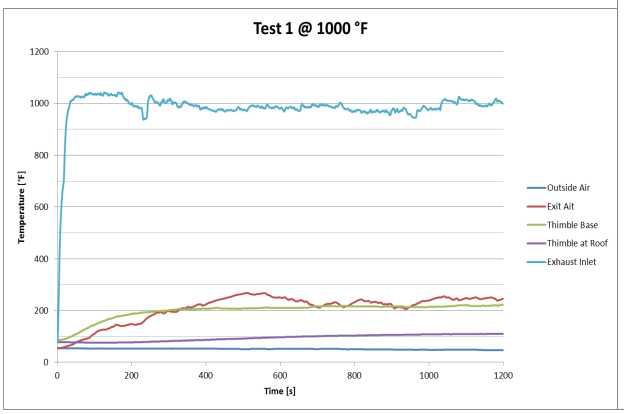
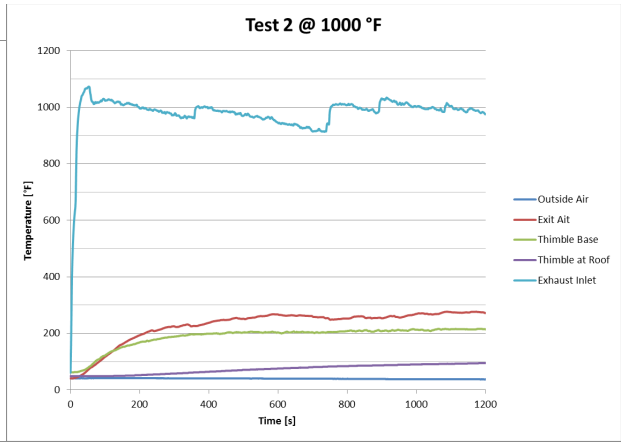
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet


Test 4 @ 800 °F
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet


Test 1 @ 1000 °F
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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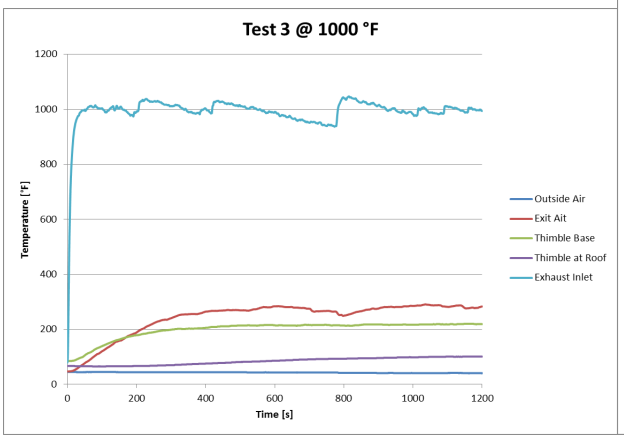
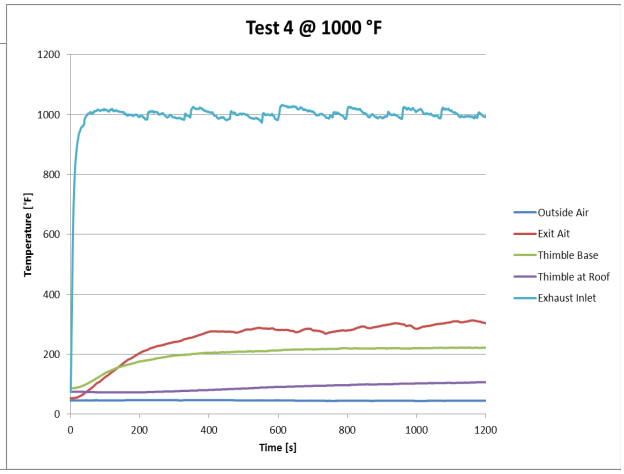
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet


Test 3 @ 1000 °F
Temperature [°F]
Time [s]
Outside Air
Exit Ait
Thimble Base
Thimble at Roof
Exhaust Inlet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Temperature [°F]
Time [s]
Outside Air
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Thimble Base
Thimble at Roof
Exhaust Inlet